Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Facilitating Opportunities for Flexible,	)	ET Docket No. 03-108
Efficient, and Reliable Spectrum Use	)	
Employing Cognitive Radio	)	
Technologies	)	
	)	ET Docket No. 00-47
Authorization and Use of Software	)	(Terminated)
Defined Radios	)	

Comments of Public Knowledge and Consumers Union

Public Knowledge and Consumers Union (hereinafter "Consumer Groups") hereby

submit these comments in connection with the Commission's *Notice of Proposed Rulemaking*

and Order, FCC 03-322 (Adopted Dec. 17, 2003) in the above captioned proceedings.

In the Consumer Groups' filings before this Commission we have consistently sought to

promote policies that defend and promote the shared resources, architectures, and content that

are owned not by individuals but by the public generally. It is precisely in the interest of

defending and promoting these resources held in common by the public that the Consumer

Groups favor development of technologies such as cognitive radio that optimize use of available

spectrum.[1] Because the Consumer Groups favor the development of cognitive radio we argue

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[1] We share the Commission's view that "cognitive radio[s] could negotiate cooperatively with other spectrum users to enable more efficient sharing of spectrum." In the Matter of Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies and Authorization and Use of Software Defined Radios, ET Docket No. 03-108, *Notice of Proposed Rulemaking and Order*, FCC 03-322, ¶ 20 (Adopted Dec. 17, 2003) [hereinafter *Cognitive Radio NPRM and Order*].

here in favor of a regulatory environment that encourages rather than inhibits software-defined

radio. We further argue that the broadcast-flag regulatory scheme, whose specifics may affect

the development of software-defined radio demodulators, should be interpreted in ways that limit

(or, ideally, eliminate altogether) its impact on the development of software-defined radio.

I.   **THE COMMISSION SHOULD FORBEAR REGULATING IN A MANNER THAT WILL INHIBIT COGNITIVE RADIO AND, IN PARTICULAR, SOFTWARE-DEFINED RADIO.**

Although the Commission correctly states in the NPRM that there is an analytical

distinction between "cognitive radio" and "software-defined radio,"[2] the NPRM also effectively

acknowledges that there is an intimate link between software-defined radio and cognitive radio.[3]

The Consumer Groups note, furthermore, that the line between software-defined radio and

hardware-based cognitive radio is not a hard or precise one. Specifically, we note that even

"pure hardware" cognitive radios may depend on software development.

The Commission correctly observes that a cognitive radio may be one that is not field-

reprogrammable or that has other end-user limitations.[4] Nevertheless, even such non-modifiable

cognitive-radio devices may be dependent on software development, because they may rely on

software that is implemented as "firmware," defined by the Webopedia as "Software (programs

or data) that has been written onto read-only memory (ROM)." [5] The Webopedia entry further

states the following: "Firmware is a combination of software and hardware ROMs, PROMs, and

EPROMs that have data or programs recorded on them are firmware."[6]

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[2] *Id*. ¶¶ 9, 10.
[3] "The majority of cognitive radios will probably be SDRs, but neither having software nor being field reprogrammable are requirements of a cognitive radio." *Id*. ¶ 10.
[4] *Id*.
[5] Webopedia entry for "Firmware," *at* www.webopedia.com/TERM/f/firmware.html, (last visited May 3, 2004).
[6] *Id*. A "PROM" is a "programmable read-only memory" chip; once a program has been written to a PROM, it remains on the chip forever. An EPROM is an erasable PROM. Generally speaking, ordinary or average users do not program PROMs or erase EPROMs at all, and those users who do such programming usually require special tools to do so.

Because the elements of firmware typically are prototyped first as software, even cognitive radio devices that, in end-user hands, are considered to be "hardware only" – including those that are not reprogrammable by end users – may be dependent on innovation in the software industry. The software industry has rarely been subject to regulation thus far, and the Commission has labored to constrain its few regulations in this area to the greatest degree possible[7] and to promote the development of software-defined radio.[8]

The Consumer Groups take the position that the development of software-defined radio functions – especially demodulation/reception – is served best by competition in an open and relatively unregulated marketplace. This competition may be served both by open-source software and by proprietary (non-open) software.

With regard to open-source software, we note that it has become increasingly clear in recent years that open-source software is a valuable source of competition and diversity in a software market that is otherwise dominated by small number of vendors of proprietary software. One reason open-source software may lead to increased competition is that it is comparatively easy for new developers to enter this marketplace without incurring licensing burdens imposed by marketplace incumbents and without dealing at all with trade-secret restrictions. The Consumer Groups believe this general principle applies in the realm of cognitive radio – and in particular for its development of modulator/demodulator/sensory functions of cognitive radio – as it applies in other markets.

Moreover, innovation in proprietary (non-open) software is also served by a relatively regulation-free environment. A major advantage of proprietary software development – shared

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[7] For example, the current regulations regarding software-defined radio limited largely if not entirely to transmission functions rather than demodulation/reception functions, even though demodulation and reception ultimately may be crucial to the proper functioning of software-defined radio. *See, e.g., Cognitive Radio NPRM and Order.*

[8] *See, e.g., id.* ¶ 12.

with open source software development – is that innovation does not always necessitate fabrication of new hardware as a prerequisite for platforms to develop new capabilities. In practical terms, this means that in a minimally regulated marketplace, software development may enable cognitive-radio-device vendors to evolve their product offerings exceedingly rapidly.

Because a relatively unregulated software market and a brisk pace of development for software-defined radio are likely to do the most to promote the development and understanding of cognitive radio devices and functions, the Consumer Groups ask that the Commission forbear from regulating software-defined radio beyond the degree that it is absolutely necessary. This forbearance necessarily should guide the Commission in administering its broadcast-flag/DTV regulations in particular, as we shall see below.

II. THE COMMISSION SHOULD NOT IMPOSE ROBUSTNESS OR COMPLIANCE REQUIREMENTS ON SOFTWARE-DEFINED RADIO DEMODULATORS.

While it may not be obvious at first glance that the Commission's policies with regard to cognitive radio and its developing broadcast-flag regulation for digital television may be headed for a collision, the fact that both regulations may have an impact on demodulator design, and in particular on software-defined radio demodulators, should be taken as a warning sign. The success of cognitive radio, including both its transmission and reception functions, may turn ultimately on whether there is a brisk market in the development of software-defined radio demodulators. This market, in turn, may be hindered by a broadcast-flag regulation that is rigidly interpreted to limit software-demodulator design and that is itself primarily crafted to apply to a different class of (hardware-based) products.

Because software loaded onto general-purpose platforms, such as personal computers, is inherently modifiable, even software-defined radio projects based on proprietary software tools

and source code will pose significant problems when it comes to imposing robustness

requirements. Imposing ***compliance*** requirements[9] on software-defined radio adds an additional

development burden on software developers working in this field, not only because it requires

additional code to make software-based demodulators search for and respect the broadcast flag,

but also because it requires the demodulator software somehow to determine – to "sense" –

whether content is being routed into secure hardware channels. This is not something software

can do by itself – it must be intimately connected to its own hardware in order to ensure that

other hardware to which it's connected is secure. ***To put the matter bluntly, software by itself***

has no "eyes" – it can only control the "eyes" (that is, sensors) that are given to it by

hardware. For this reason, the software component of software-defined radio will inherently be

unable to meet, by itself, any compliance requirements; compliance is contingent on the presence

of sensor devices that are instantiated in hardware, since a compliant device is one that senses

whether other, connecting devices are playing by the rules.

Of course, one may reasonably conclude that software by itself lies outside the scope of

the broadcast-flag regulation, just as general-purpose hardware (such as general-purpose

computers) lies outside that regulation; software by itself cannot be a demodulator (or for that

matter a "downstream device"). It is only the ***combination*** of demodulation software and

general-purpose hardware that might conceivably meet compliance requirements or that might be

required to under the current scheme.

The fact that hardware and software that are themselves not within the scope of the

regulation may be combined into demodulators thus raises important enforcement

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[9] In the Matter of Digital Broadcast Content Protection, MB Docket 02-230, *Report and Order and Further Notice of Proposed Rulemaking*, FCC 03-273, Appendix B, § 73.9003 Compliance Requirements for Covered Demodulator Products: Unscreened Content; § 73.9004 Compliance Requirements for Covered Demodulator Products: Marked Content. (Nov. 3, 2003) [hereinafter *Broadcast Flag Order and FNPRM*].

considerations, should the Commission attempt to enforce compliance requirements in the arena of software-defined radio demodulation. Specifically, the software and hardware components of software-defined radio are inexpensive, readily modifiable, widely duplicable (in the case of software), and universally available. As a result, an interpretation of the broadcast-flag regulation to include software-defined radio (or, in the alternative, a failure to exempt software-defined radio from the broadcast-flag regulation) raises enforcement problems that may be intractable. The Commission could find itself in the position of regulating every programmer, every personal computer, and every antenna, because the combination of these elements might lead to a noncompliant demodulator. Furthermore, since the Commission is seeking both to promote cognitive radio and to prevent cognitive-radio development from being hindered by regulation, a finding by the Commission that software-defined radio necessarily lies outside the scope of the broadcast-flag regulatory scheme would be consistent with the Commission's pro-innovation policies as stated in the cognitive-radio proceeding.

Even if software-defined radio demodulators are deemed to fall under the broadcast-flag regulation, and even if software-defined radio demodulators easily could be made compliant, it may not be clear whether such compliant systems also can be made robust.[10] The argument against robustness can be stated as follows: since all software, whether open-source or proprietary, is inherently modifiable, a software-defined radio demodulator that is otherwise compliant in terms of its handling of flagged content cannot be robust since it may be tampered with. The Consumer Groups take the converse view, however, given that the Commission has set a robustness threshold that centers on whether an ordinary person – as distinct from an expert

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[10] "The content protection requirements set forth in the Demodulator Compliance Requirements shall be implemented in a reasonable method so that they cannot be defeated or circumvented merely by an ordinary user using generally-available tools or equipment." *Id.* Appendix B, § 73.9007 Robustness Requirements for Covered Demodulator Products.

– can circumvent the content protection mechanisms in complaint software-defined radio demodulators. The average person does not ordinarily write programs or engage in circumvention or alteration of software, be it open-source or proprietary. For this reason, we conclude that any software-defined radio demodulator that might be compliant is, almost by definition, "robust" as the Commission has defined that term.[11]

Apart from the issue of whether the software-defined radio can meet the parameters laid out by the Commission in its current broadcast-flag ruling, there remains the troubling question of whether the Commission should attempt to regulate the writing of the software that would be a component of software-defined radio. Most courts that have considered the question of whether software qualified as First Amendment-protected speech have concluded that it does.[12] It follows, then, that regulations aimed at constraining the writing of certain kinds of software create the potential for legal challenges on First Amendment grounds

In sum, then, the Consumer Groups believe that the Commission must tread lightly when it considers the extent to which software-defined radio can and should be regulated under the broadcast-flag regime. Any attempts to shoehorn software-defined radio into a scheme that is designed primarily for hardware-based dedicated digital-television equipment may undermine the development of cognitive radio and suppress innovation generally. Furthermore, such regulation necessarily must be broad to reach the components of software-defined radio, and may pose significant enforcement and First Amendment problems.

III.   CONCLUSION

The Consumer Groups' goal in this filing is to underscore the potential and actual conflicts between the Commission's interest in promoting cognitive radio and its efforts to

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[11] *See id.*
[12] *See e.g., Bernstein v. U.S. Dep't of State*, 922 F.Supp. 1426, 1436 (N.D. Cal. 1996).

determine how to apply its broadcast-flag regulation to a class of product that does not easily fit

that regulatory scheme. Harmonizing the policies and rules between these two proceedings may

be difficult; nevertheless, the Consumer Groups argue here that harmonization will be necessary

if the Commission's "interest" in promoting cognitive radio and software-defined radio is to be

properly protected. Furthermore, the right balance, we argue, is one that allows an unregulated,

undistorted marketplace to fuel the development of software-defined radio products and features.

        Respectfully Submitted,

         /s/
        Mike Godwin
        Nathan Mitchler
        Public Knowledge
        1875 Connecticut Avenue, NW
        Washington, DC 20009
        (202) 518-0020

         /s/
        Christopher Murray
        Consumers Union
        1666 Connecticut Avenue, NW
        (202) 462-6262
        Washington, DC 20009

        Counsel for Public Knowledge and
May 3, 2004   *Consumers Union*